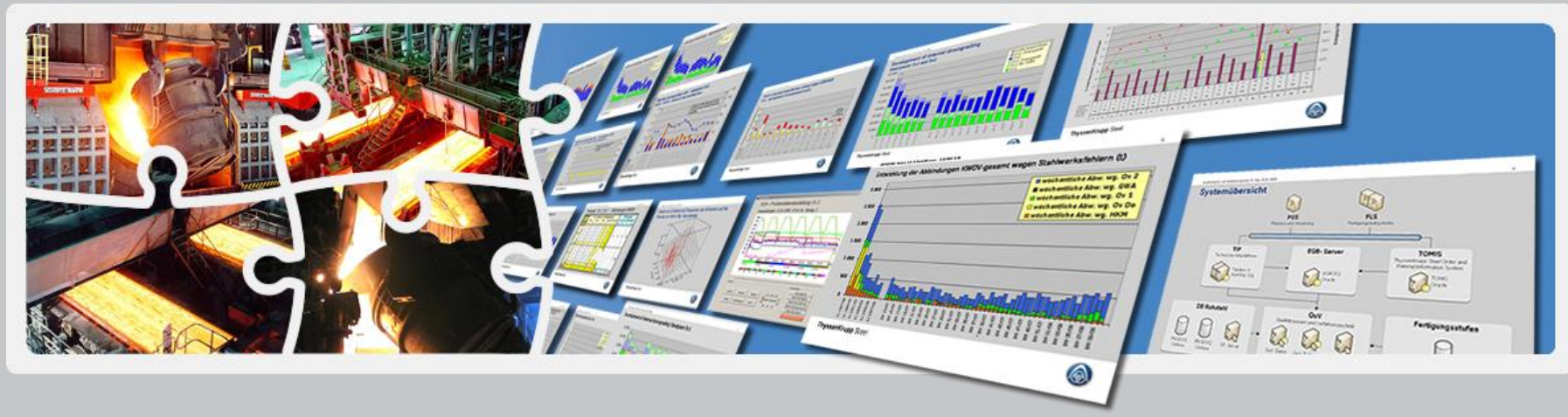
Application of thermodynamic modeling in the steel metallurgy

Z. Taszner, J. Rudnizki – GTT Workshop, September 14 – 16, 2011



ThyssenKrupp Steel Europe
Rohstahl / Qualitätswesen und Verfahrenstechnik

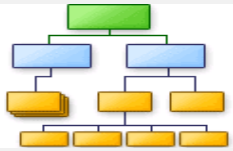
ThyssenKrupp

Agenda

- Introduction
- Thermodynamic application at TKSE
- FactSage - application examples
  - Solubility limits in TBM-steel
  - Precipitation reactions
  - Solidification of peritectic steels
  - Heat balance calculations for BOS
  - Phase diagrams for slag systems

Introduction

Qualitätswesen und Verfahrenstechnik



Dr. Müller
QuV

Dr. Petry
Process Development

Dr. Rudnizki
Projects Metallurgy

Shepherd
Projects Metallurgy

Dr. Taszner
Projects Metallurgy

Responsibilities (Process Development)

- Technological support for steel production
- Metallurgical process optimization, thermodynamic modeling
- Development and supply of engineering tools for the process and quality control

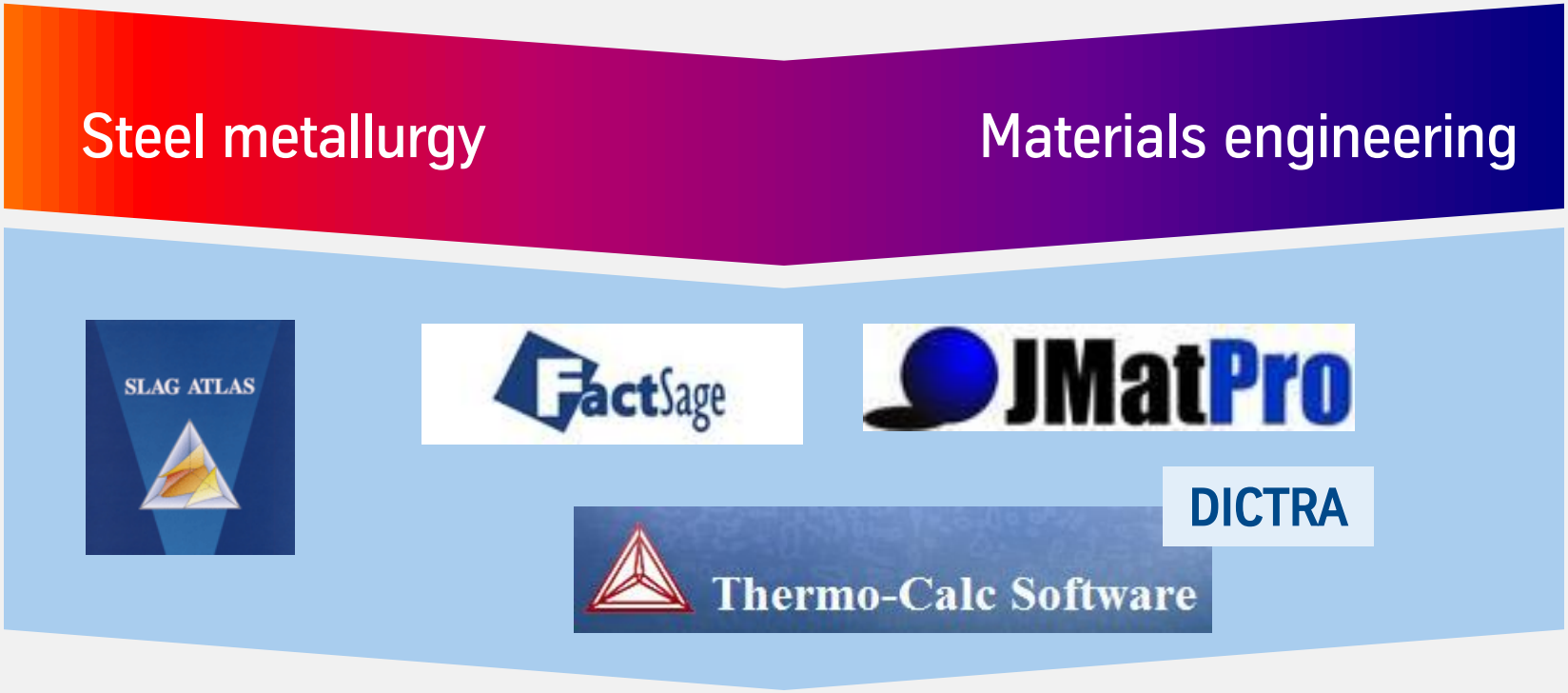
Beirer
Quality Control

Fiedler
Quality Control external/CSA

Linneweber
Quality Control Ox2

Dr. Toulouse
Quality Colntrol Ox1

Thermodynamic tasks and applications at TKSE

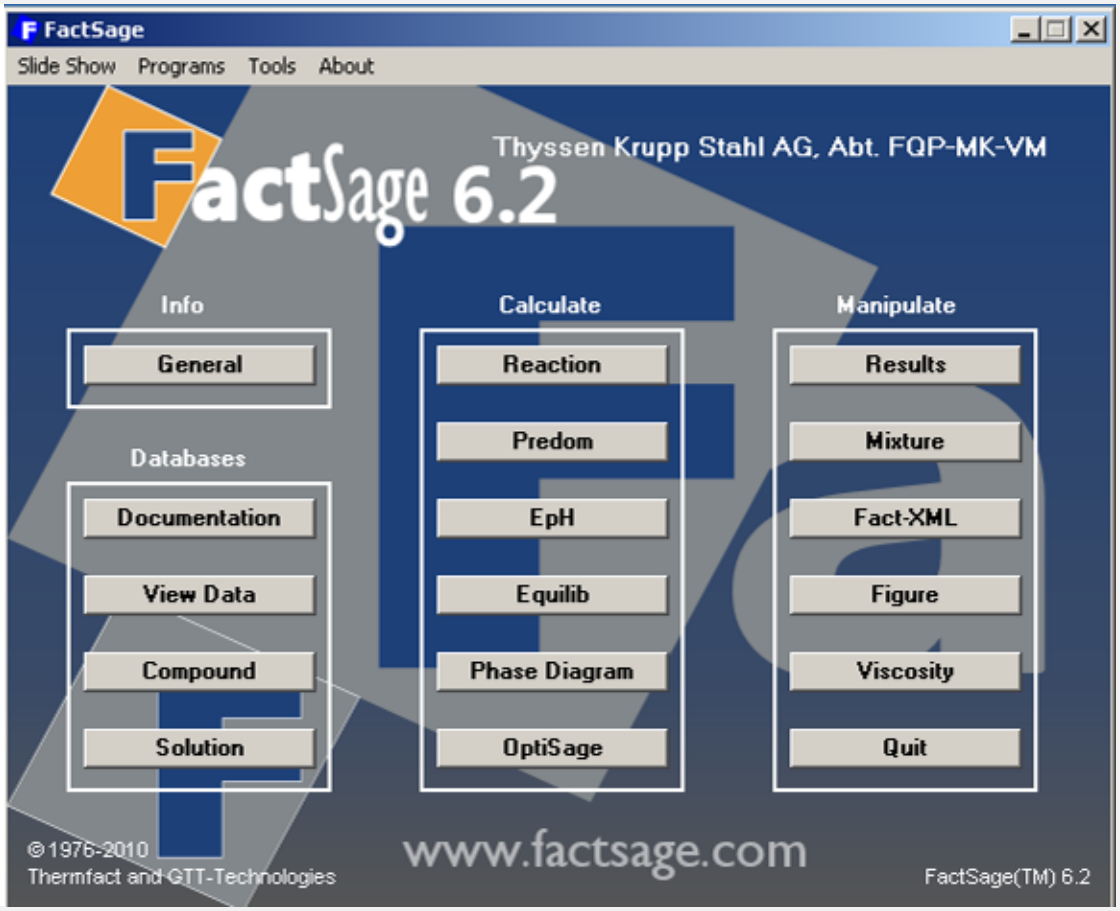


FactSage:

Calculation of thermodynamic functions, phase diagrams, equilibria and reactions in steels and slags, mass and heat balances

Software: FactSage (Network)

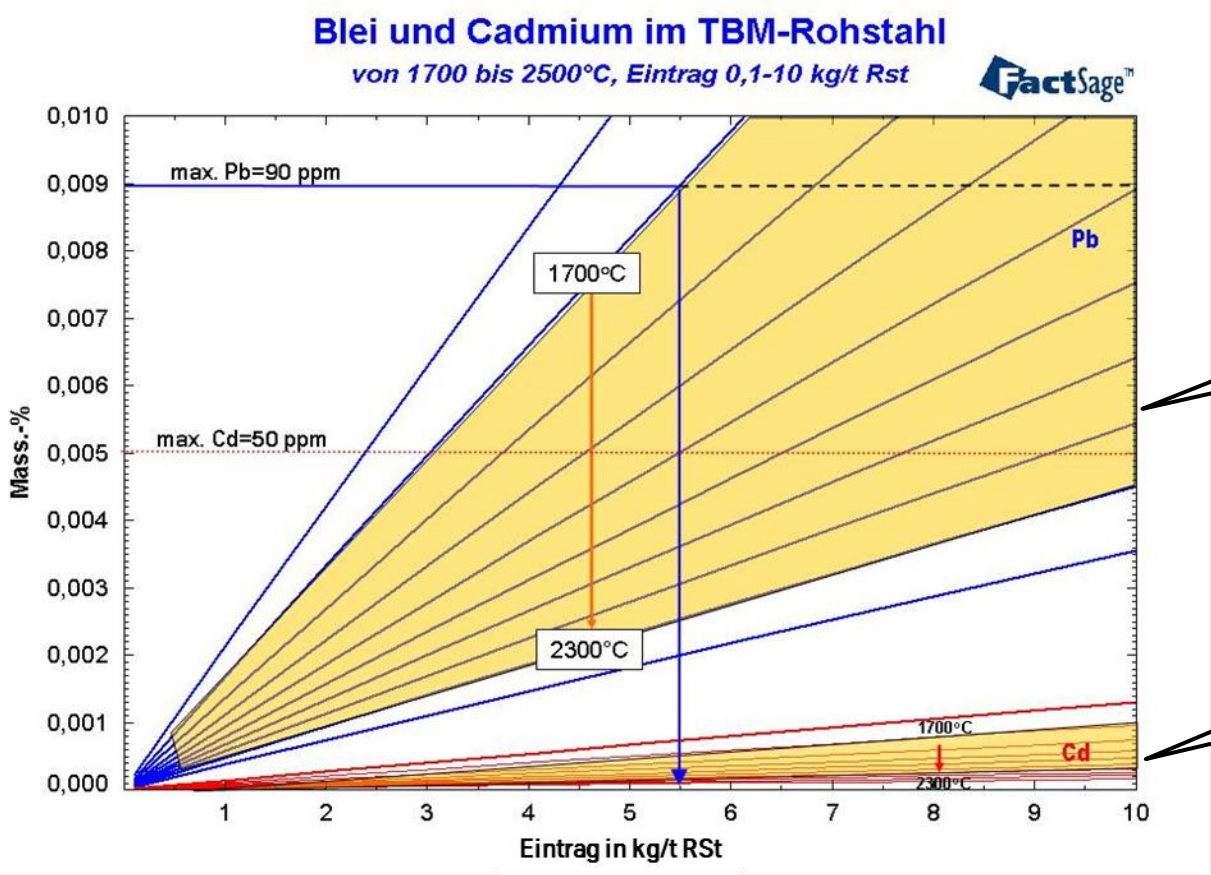
- Thermodynamic databases
- Gibbs energy minimization
- Calculation tool for
  - → phase diagrams
  - → reactions
  - → equilibrium
  - → slag viscosity
- Data set optimization
- Visualization



http://www.gtt-technologies.de/
http://www.factsage.com/

Application example: Solubility limits in TBM-steel

- Study for the compliance of the concentration limits according to customer request of 90 ppm Pb and 50 ppm Cd in TBM-steel

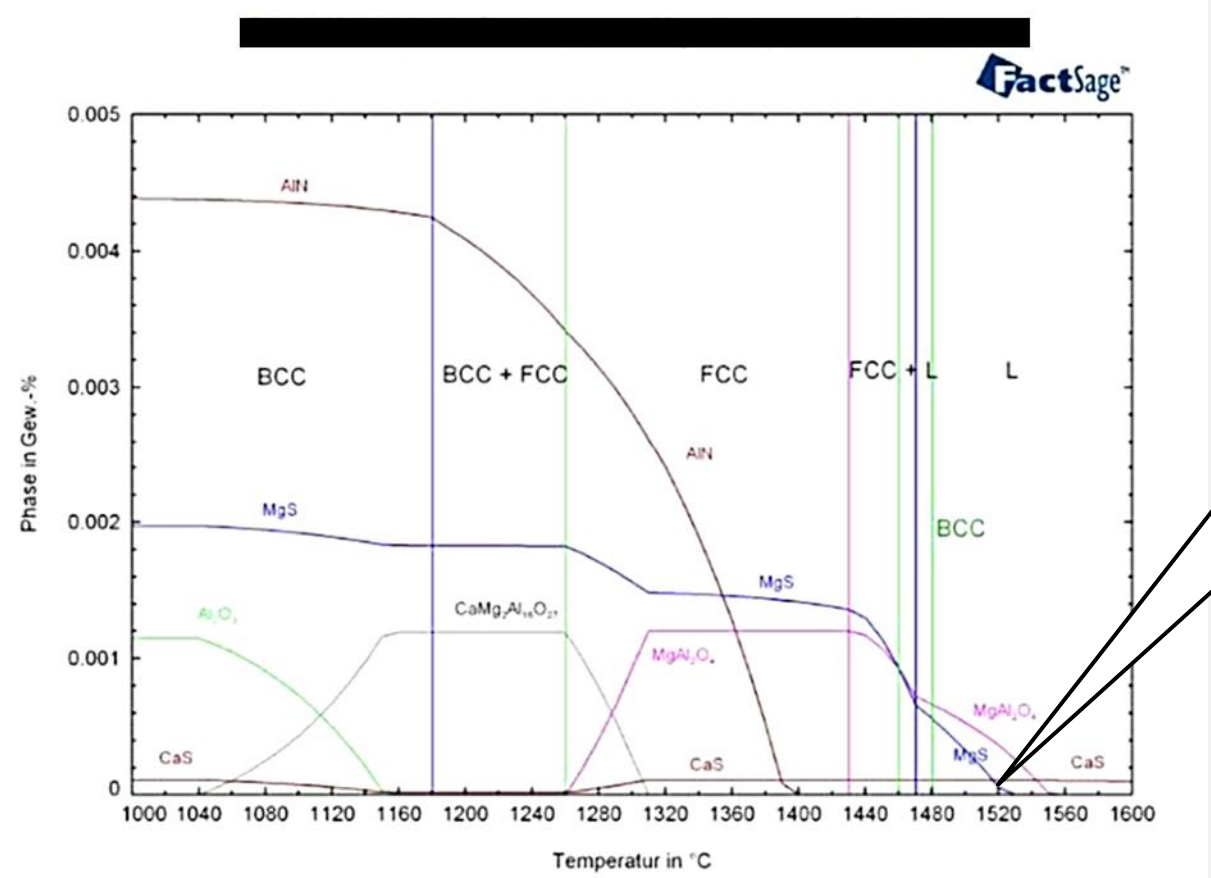


Maximum solubility of 90 ppm Pb at 1700°C can not be achieved by BOF process. An input of ca. 5,5 kg/t heavy metal is not realistic.

50 ppm limit for Cd could not be reached under reasonable metallurgical assumptions.

Application example: Precipitation reactions

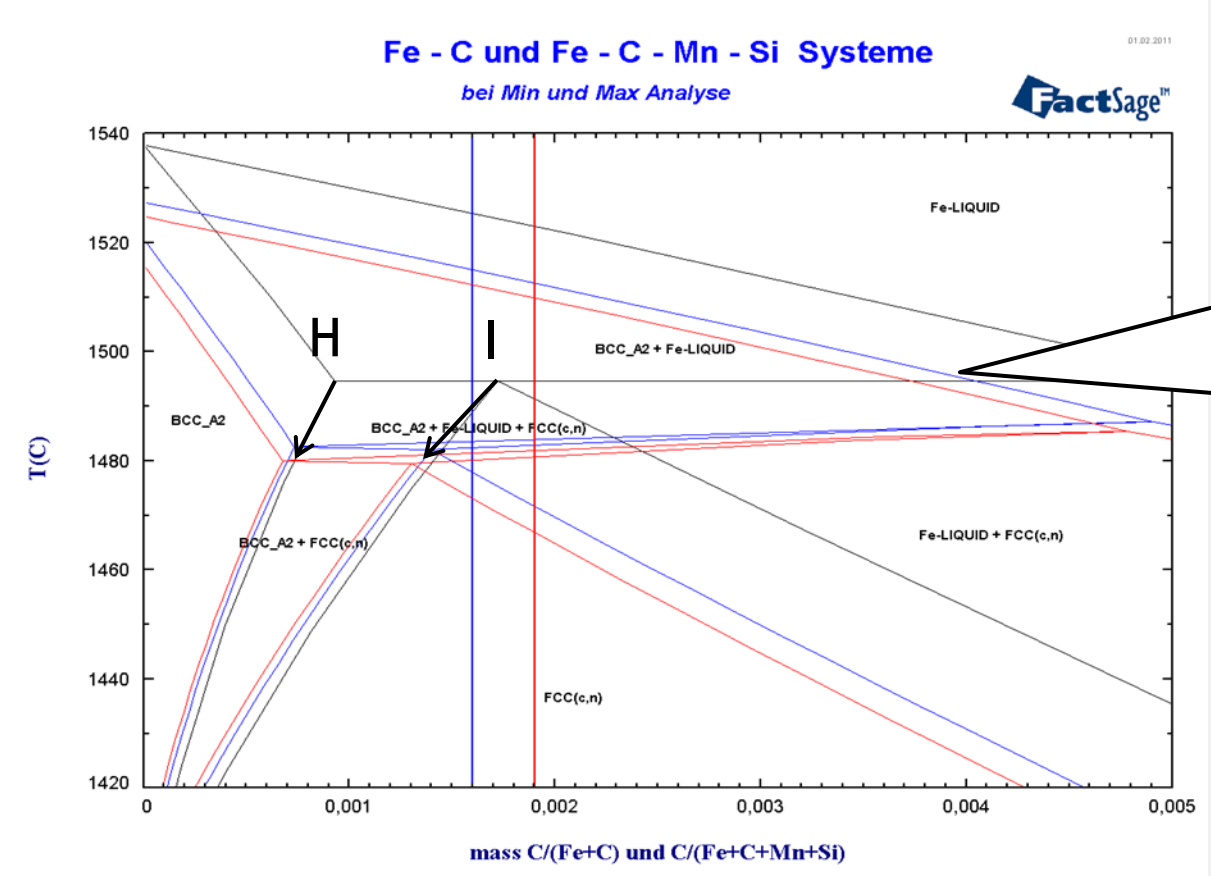
- Contribution to the determination of relationship between change in the magnetical properties of electrical steels and non-metallic inclusions



MgS is thermodynamically stabile below 1520°C. Critical configurations of MgS can be avoided by reducing the Mg-content.

Application example: Solidification of peritectic steels

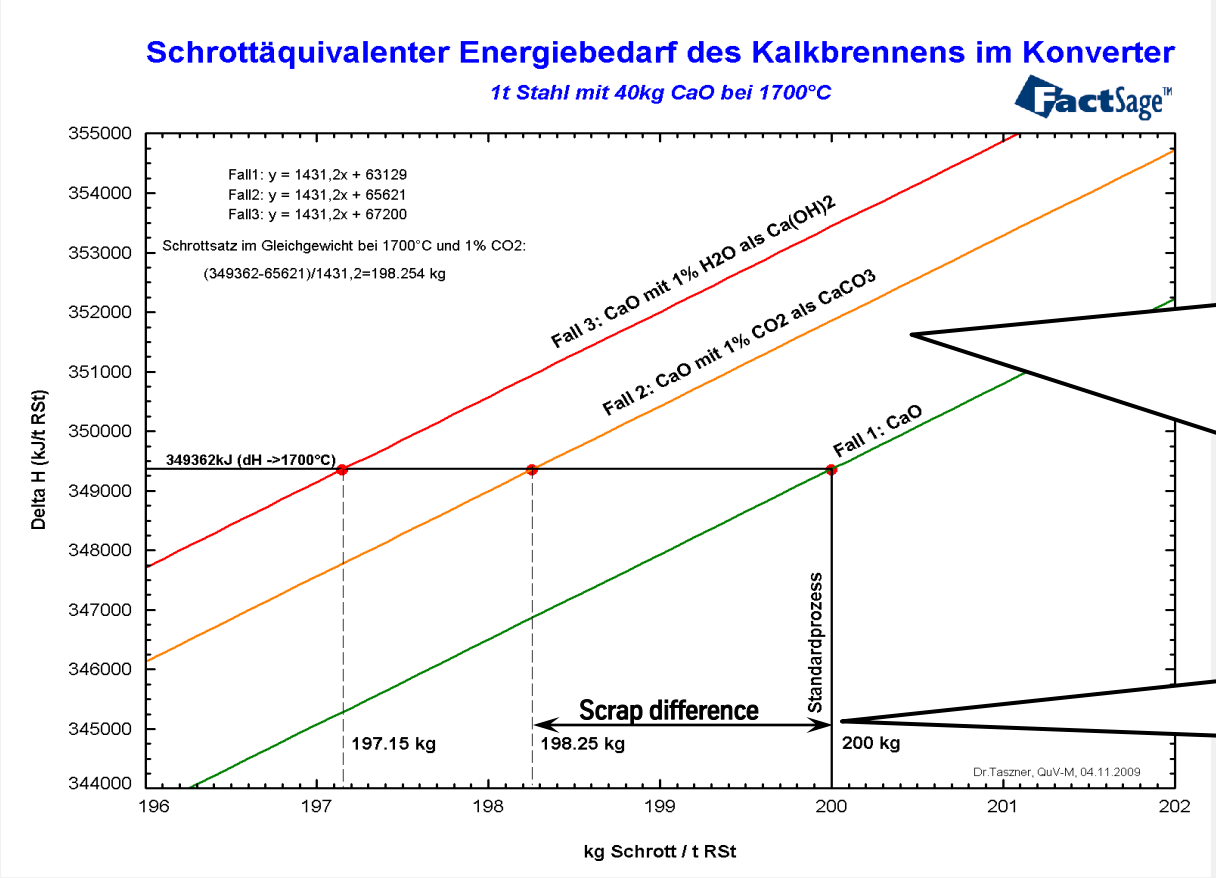
- Determination of specific influences of alloying elements on the C-equivalent using phase diagrams



Prediction of the peritectic behaviour and prevention of the critical concentrations by adjusting the chemical composition

Application example: Heat balance calculations for BOS

- Detection and quantification of negative influences of „lime-burning“ on the scrap proportion in the oxygen blowing process



case 1:
scrap/crude steel equilibrium with normal lime
case 2:
equilibrium with not fully burned lime (1% CO2)
case 3:
equilibrium with not fully burned lime (1% H2O)

not fully burned lime reduces scrap amount in converter which must be compensated by hot metal

Application example: Slag systems

- Calculation of slag systems for the mapping of own process slags, slag routes

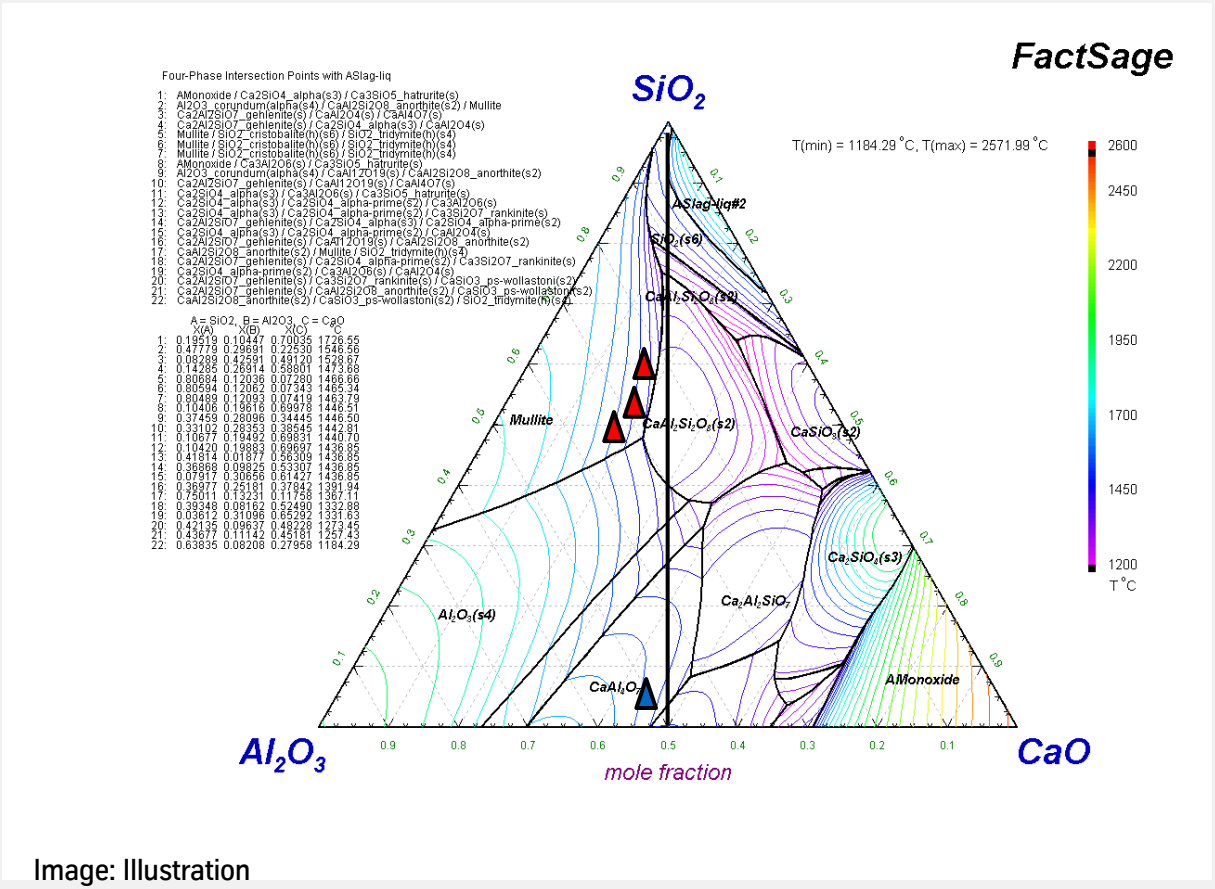


Image: Illustration

Al_2O_3-CaO-MgO-SiO_2
Al_2O_3-CaO-NaO-SiO_2
Al_2O_3-MgO-NaO-SiO_2
CaO-MgO-NaO-SiO_2
Al_2O_3-CaF2-CaO-MgO
Al_2O_3-CaF2-CaO-SiO_2

Thank you for your attention!